GRADUATE COURSE DESCRIPTIONS for the Degree of Master of Eng. in Civil Engineering,

Major: *Structural Engineering*

1610500 Engineering Mathematics 3 Cr. Review on Basic Mathematics, Special Functions, Calculus of Variations, Difference Equations, Vectors and Matrices, Fourier Analysis, Partial Differential Equations, Complex Analysis

1612525 Theory of Elasticity 3 Cr. **Theory of Stress:** Definition of Stress, Principal Stresses ,Mean and Deviator Stress Tensors, Differential Equation of Motion, **Theory of Strain**: Displacement, Rigid Body Motion, Pure Deformation, Gradient of the Displacement Vector, Principal Stresses, Strain Tensor in terms of Displacement Components, **Constitutional Equations**: Strain Energy, Generalized Hook"s Law, Isotropic Materials, Orthotropic Materials, **Three Dimensional Equations of Elasticity**: Equations of Elasticity in terms of Displacements(Navier Equations), Compatibility Equations in terms of Stresses(Michell Equations), **Two-Dimensional Equations of Elasticity**: Plane Strain Problems, Plane Stress Problems, Method of Solution of 2-D Problems,Two Dimensional Problems in Polar Coordinates, **Special Problems**: Torsion of Noncircular Prismatic Bars (Elliptic Section, Rectangular Section, Triangular Section)

1612526 Matrix Analysis of Structures 3 Cr. Review of Matrix Algebra, Matrix Inversion Routines, Derivation of Slope-Deflection Equations, Mathematical Modeling of Structural Members, Stiffness Method, Plane Structures including Trusses, Beams and Frames, Effect of Support Settlement, Members' Misfit and Temperature Changes, Space Structures (Trusses, Frames and Grids), Special Topics (Band Width, Static Condensation,…), Sub-Structuring

1612527 Dynamics of Structures 3 Cr. **Single Degree-of-Freedom Systems:** Equations of Motion: System Properties: Mass, Spring, Damper, Force - Displacement Relation, Force -Velocity Relation, Force - Acceleration Relation, Force Excitation, Earthquake Excitation, Solution of Differential Equation : Free Vibration: Undamped Systems, Damped Systems, Force Vibration: Undamped Systems, Damped Systems, Response to Harmonic and Periodic Excitations, Response to Arbitrary, Step and Pulse Excitations, Numerical Evaluation of Dynamic Response: Time Stepping Methods, New marks Method, Generalized Single-Degree-of-Freedom Systems: Rigid Body Assemblage , Systems with Distributed Mass and Elasticity, Lumped Mass System: Shear Building, **Multi- Degree-of Freedom Systems:** Planar or Symmetric Plan Systems, Asymmetric Plan Buildings, Dynamic Analysis and Response to Linear Systems, Modal Analysis, **Introduction to Nonlinear Systems**

1612528 Theory of Plates and Shells 3 Cr. Introduction, Elements of Plates Bending Theory, Circular Plates, Rectangular Plates, Plates Of Various Geometrical Forms, Plate Bending by Numerical Methods: Energy Methods, Finite Differences, Finite Elements, Finite Strips , Stability of Plates

1612529 Finite Element Method 3 Cr. **Introduction to the Use of Finite Elements:** Physical Problems and Mathematical Models, **Formulation:** Mathematical Fundamentals, Weighted Residual Approximations, Weak Formulation and Galerkin Method, Approximation in Solution of Differential Equations , Approximate Solution to Systems of Differential Equations, Differential Equations in Engineering Problems (Solid Mechanics, Heat Conduction), Virtual Work for Solid Problems, Variational Principles in FE Formulation, Continuity Requirements, Piecewise Trial Functions, **The Concepts of Element and Shape-Function**: One Dimensional Lagrange Shape-Functions (Linear and Higher Order Elements), Hermite Polynomials for Shape-Functions with Higher Continuity, Two Dimensional Quadrilateral Elements with Lagrange Polynomials, The Concept of Mapping, Isoparametric, Sub-Parametric and Super-Parametric 2D/3D Elements, Triangular an Tetrahedral Elements, Numerical Integration, Plate Formulation and Elements, Axisymmetric Solid/Shell Problems and the Associated Elements .

1612530 Stability of Structures 3 Cr. Introduction: What is buckling?, Importance of Buckling Load, Historical Review, Buckling and Post Buckling of Bars with Finite Degrees of Freedom, Buckling and Post Buckling of Columns, Buckling of Beams Columns, Inelastic Buckling of Plates, Slope Deflection and Moment Distribution Methods for Buckling Analysis of Frame, Finite Element Method for Frame Buckling, Exact Finite Element Method for Frame Buckling, Lateral Torsional Buckling of Beams, Local and Post Local Buckling of Plates, Finite Element Method for Plate Buckling, Finite Strip Method for Plate Buckling

1612531 Prestressed Concrete 3 Cr. Principle and Methods of Prestressing, Prestressing Materials, Flexure : working stress analysis and design, Flexure : Ultimate strength and design, Design for shear and Torsion, Computation of Prestress Losses, Deflection Computation, Analysis and design of composite beams, Continuous Beams

1612532 Design of Bridge 3 Cr. Criteria for Bridge Design, Highway Bridges Loading, Design Traffic Lanes, Live loads on Highway Bridges, Impact on Highway Bridges, Longitudinal Forces on Highway Bridges, Centrifugal Force on Highway Bridges, Sidewalk Loading, Wind Loading, Thermal Forces on Highway Bridges, Uplift on Highway Bridges, Forces of stream Current, and Ice on Highway Bridges, Earth Pressure on Highway Bridges, Earthquake Pressure on Highway Bridges, Loading Combinations on Highway Bridges, Load-Factor Design Loadings, Influence Lines and Design Forces, Design of Bridge Decks, Design of Reinforced Concrete Decks, Design of Precast Concrete Decks, Design of Prestressed/Post-tensioned Concrete Decks, Design of Composite I-Girder Decks, Design of Composite Box-Girder Decks, Design of Orthotropic-Plate Girder Decks, Design of Elastomeric Supports, Design of Abutments and Piers , Bridge Project

1612534 Advanced Steel Structures 3 Cr. Stability of Columns, Stability of Frames, Torsional Analysis And Design of I Beams, Lateral – Torsional Buckling of Beams, Moment Magnification Factors in Beam – Columns, Plastic Analysis and Design of Continuous Beams, Design of Composite Beams

1612537 Advanced Concrete 3 Cr. Constitutive Laws of Reinforced Concrete Materials, Analysis and Design of Concrete Tanks and Reservoirs , Analysis and Design of Concrete Silos and Bunkers , Analysis and Design of Concrete Shells, Ductility in Reinforced Concrete Structures

1612540 Reliability of Structures 3 Cr. Events, probability of events, probability of failure of determinate structures, faults & probability of failure of indeterminate structures, application of normal & lognormal and extreme value probability laws for the calculation of safety of structures.

1612538 Plastic Analysis and Design of Structures 3 Cr. Basic concept, plastic bending, ultimate loads of beams and frames, plastic design of beams and columns, beam-columns, deflections.

COURSE DESCRIPTIONS for the Degree of Master of Eng. in Civil Engineering, Major: *Water Engineering*

1614575 Advanced Hydraulics 3 Cr. Cavitations control in rapidly varied flow. Supercritical flow in open channels. Specially varied flow. Gradually varied and rapidly varied unsteady flow. Storage and river flow roofing.

1614576 Advanced Hydrology 3 Cr. **Course Objectives**: To introduce further advanced topics of engineering hydrology to complement the undergraduate course. To analyze the conceptual and digital models for the simulation of the hydrologic processes in watersheds and for runoff prediction. More emphasis is given to application of the methods introduced in analyzing the hydrological processes. **Course Outline**: Review of Hydrology , Deterministic Lumped Unsteady Flow Models (Chap. 7), General system model, Response functions of linear systems, Unit hydrograph, Runoff hydrograph computation, Hydrologic Routing (Chap. 8), Lumped system,
Reservoir routing methods, River routing, Hydrologic Design (Chap. 14 & 15): Design Storms, Design Flows, HEC-HMS (software), Application of Data-Driven Models in Hydrologic Processes (Handouts), Rainfall-Runoff process, Rainfall forecasting/disaggregating, Groundwater, Application of GIS in Hydrology .

1614577 Hydrodynamics 3 Cr. **Introduction, Basics of Fluid Mechanics**: Basics, Fluid statics Fluid dynamics, Dimensional analysis, Pipe flow, External flows, **Laminar Flow, Introduction**: Derivation of the Navier-Stokes equations, Solution of Navier-Stokes equations-Parallel Flows, **Turbulent Flow**: Introduction, Reynolds equations, Turbulent flow in pipes, Turbulent flow in wide rectangular channels, **Applied Hydrodynamics**: Introduction, Euler and Bernoulli equations, Stream and velocity potential functions, flow net, Simple flows and combinations of simple flows, **Laminar Boundary Layers**: Introduction and concept of boundary layer, Estimates for main properties of laminar boundary layers, Prandtl boundary layer equations, The Blasius problem - laminar boundary layer on a flat plate, Different boundary layer thicknesses, Integral momentum equation, Approximate solution of the Blasius problem, **Turbulent Boundary Layer**: Preliminary ideas about turbulent boundary layers, The differential and integral equations, Law of the wall and defect law, Constant pressure turbulent boundary layers on rough walls, Turbulent boundary layers with pressure gradients

1614578 Numerical Methods in Water Engineering 3 Cr. **Introduction and Overview of Class**, **Distributed Surface Flow Routing**: Basic Equations and Classification of Models, Kinematic, Diffusion and Full Dynamic Eqs., Analytical and Numerical (FD) Solutions, **Physics of GW Flow, Finite Difference Method**, Steady State Flow (Laplace and Poisson's Eq.), Transient Flow, Solution Methods, **Finite Elements Method:** 1-D and 2-D Problems, Steady State Flow, Transient Flow, **Advanced Topics – Machine Learning Methods**, **Application of numerical methods in water engineering**: Surface Water Flow (open channel), Pipe Flow
Groundwater Flow

1614582 Water Resources System Analysis 3 Cr. **Introduction:** Water resources planning, The system concept and characteristics, Issues in hydrosystems engineering, Design vs. analysis, Conventional vs. optimization methods, Reservoir system operation, **Economics for Hydrosystems:** Engineering economic analysis, Evaluation of time streams of benefits and costs, **Simulation:** Water balance simulation of a reservoir, Reservoir/River system configuration and operation, **Deterministic Optimization:** Plan formulation, Objective functions and constraint equations, Lagrange multiplier, Linear Programming (LP), Forms of LP, Solution algorithms for LP, Simplex method, Artificial variable methods, Sensitivity analysis, Simulation / Optimization methods, Dynamic Programming (DP), Concepts, Recursive equations, Applications, Integer Programming (IP), Mixed-integer linear programming, Chance constraint models, **Search Methods:** Genetic algorithms (Evolutionary method), Artificial Neural Networks (Simulation method)

1614487 River Engineering 3 Cr. **Overview of River Engineering:** Introduction, River morphology, Geometry of fluvial channels, River planning and design, River investigations, **Sediment Transport:** Hydraulic and geomorphic characteristics of river, General Physics of sediment transport, Physics of flow, Initiation of motion, Resistance to flow in alluvial channel, Suspended sediment transport, conservation of mass, Bed deformation, Momentum equation, Flow in curved channels, Degradation and aggradation , **Scour & Scouring Control:** Type of scour, Estimating scour, Erosion control, Bridge crossing, **Principles of Physical Modeling**

1614579 Unsteady Flow in Pipeline Systems 3 Cr. **Review of Steady Flow**: Basic hydraulic equations, Head loss, Steady state analysis, Single pipe analysis, Pipe network analysis, **Fundamental Concepts of the Unsteady Flow**: Introduction, Problems, Consequences, Differential momentum equation , Rigid water column theory, The momentum equation and pressure head in a horizontal pipe, Unsteady flow in series pipes, Unsteady flow in parallel pipes, Minor losses, Elastic theory, Wave speed, Thin-walled pipes, Other types of conduits, Effect of air, Differential continuity equation, **Analysis of Unsteady Flow**: Introduction, Graphical method, Characteristics methods, Approximate method , Complete method, Different interpolation

schemes, Effects of parameters on results, **Complex Systems**: Series pipes, Branching pipes, Minor losses, Valves, Pumps, **Control Devices and Techniques:** Valves, Pump power failure, Surge tanks, air chamber, Other techniques

1614580 Water Resources Quality Control 3 Cr. Physical, Chemical, and Biological Parameters Relating to Streams, Estuaries, Lakes and Reservoirs, Water uses and Water Quality Goals, Objectives and Criteria, Limnology, Stratification, Eutrophication, Principles of Water Quality Modeling and Waste-load Allocation, Transport and Transformation of Chemicals in Water Resources.

1614581 Groundwater 3 Cr. Introduces Fundamental Government Principles, The Movement of Water and Contaminants in Groundwater Systems Physical Properties of Groundwater and Aquifers, Principles and Fundamental Equations of Porous Media Flow and Mass Transport, Well Hydraulics and Pumping Test Analysis, Groundwater Quality and Contamination.

1614585 Water Distribution Systems 3 Cr. Emphasizes the Mechanics of Water Flow in Pipes and Pipe network Systems , Municipal Water Uses and Quantities, Conservation Laws and Headless Formulae, Equivalent Pipes, Reservoir, Pumps, Formation of Equations, Hardy Cross Method, Newton-Raphson Method, Linear Theory Method, Surge and Water Hammer Problems.

1614588 Wastewater Collection Networks 3 Cr. The Basic Methods of Wastewater Flow and Measurement, Types of Collection Systems, and Sewers, Design of Gravity - Flow Sewers, Sewer Appurtenances, Infiltration / inflow, Pumps and Pump Systems, Design of Pumping Stations, Analysis of Pump Systems, Corrosion and Odorous Control

1614597 Advanced Groundwater 3 Cr. Introduction to Groundwater flow. Properties of aquifers: porosity, hydraulic conductivity, specific yield, specific storage, transmissivity. Basic assumptions, Darcy's law, Solution of flow equations, Unsteady flow in aquifers (confined and unconfined). Regional groundwater flow, Transient flow in regional groundwater systems, Groundwater flow to wells. Soil moisture and groundwater recharge, Theory of unsaturated flow. Interaction of groundwater and surface water (lakes, wetland and rivers). Groundwater flow modeling techniques, simulation of two and three-dimensional groundwater systems. Numerical methods in groundwater flows (finite differences), different initial and boundary conditions, stability of scheme. MODFLOW- 2000 Description, Space and time discretization, External source and stress, Solver packages, Case study. Management of groundwater, Concepts of basin management. Conjunctive use of surface water and groundwater, optimal control groundwater management models, Case study

1614598 Hydraulic Structures 3 Cr. Elements of dam engineering and related hydraulic structures, introductory perspectives. Site assessment and selection of type of dam, involving hydrological, hydraulic, Geotechnical, river engineering and loading aspects. Diversion works , Hydraulic design of dam outlet works and spillways., Intakes and bottom outlets, Energy dissipation in hydraulic structures (stilling basins, plunge pools, stilling wheels), Hydroelectric power development. Two-phase air-water and water-sediment flows in hydraulic structures, Hydraulic structures construction, instrumentation and surveillance,

1616551 Advanced Soil Mechanics 3 Cr. Basic concepts of soil mechanics, Physical properties of soils, Stress distributions in soil medium, Permeability and flow nets, Soil consolidation, Settlements of soil under loads , Shear strength of soils, Failure criteria, Cam clay model (original and modified),

1616557 Earth Dams 3 Cr. In this course the design and analyses of earth and rockfill dams are discussed and it can be divided into five basic subjects as: Materials cut off methods, drainage systems, design and foundations.

COURSE DESCRIPTIONS for the Degree of Master of Eng. in Civil Engineering, Major: *Soil & Foundation*

1616550 **Soil and Fondation Dynamics** 3 Cr. Vibration of single & multi degree freedom systems, fundamentals of soil mechanics, wave propagation & wave velocities, liquefaction phenomena, landslide phenomena, dynamic tests of soils, soil-structure interaction.

1616551 **Advanced Soil Mechanics** 3 Cr. This course is a continuation of the soil mechanics theories and the recent empirical formula for this subject.

1616552 **Theory of Plasticity in Soil** 3 Cr. This course should cover the main theories of materials plasticity, especially soils and the application of Mohr-coulomb, Von-Mises, and tresca plasticity theories to the practical problems of soil mechanics and foundation engineering.

1616553 **Rock Mechanics** 3 Cr. This course should cover the principles of physico-mechanical properties of rocks as an eng. material. The main subjects in this course are: Physico-technical indices of rocks in both cases, i.e. samples and in situ, shear and tensile strength of rocks, rock structures; and rock technology.

1616554 **Advanced Foundation Engineering** 3 Cr. This course covers some advanced discussions about the slope stability, retaining structures, bearing capacity theories and underground structures.

1616555 **Numerical Methods in Soil Mechanics** 3 Cr. This course should cover the basic methods of approaching the solution of problems in soil mechanics and foundation engineering by the numerical methods such as the finite difference. The primary subjects which should be discussed by the numerical approach are: Settlement, consolidation, failure, seepage problems and the slope stability.

1610501 **Advanced Engineering Geology** 3 Cr. The geology of reservoir and dam sites, the geology of cuttings and tunnels, and site investigations.

1610502 **Continuum Mechanics** 3 Cr. Basic concept, tensor algebra, tensor calculus, kinematics of deformation, the stress concept and the thermo-mechanical balance laws, selected topics in linear elasticity theory, selected topics in fluid mechanics, special theories of generalized continue.

COURSE DESCRIPTIONS for the Degree of Master of Eng. in Civil Engineering
Major: *Environmental Engineering*

1614586 Water Treatment 3 Cr. Water quality and standards, Aeration and air stripping, Mixing, Coagulation and flocculation, Sedimentation, Floatation, Filtration: Granular medium filter, Adsorption: Activated carbon, Disinfection: Chlorination, Chemical precipitation: Water softening, Ion exchange, Membrane processes, Chemical oxidation: Iron and manganese removal, cyanide removal, Scale formation and corrosion, Taste and odor control, Treatment and disposal of residuals, Synthesis of treatment facilities,

1614589 Wastewater Treatment 3 Cr. Wastewater quality and standards, Process analysis and design, Physical unit operations: Screening, flow equalization, grit removal, primary sedimentation, Fundamentals of biological treatment, Activated sludge processes, Biological nitrogen removal processes, Biological phosphorus removal processes, Trickling filters, Rotating biological contactors, Anaerobic biological treatment processes, Lagoon treatment systems, Land treatment systems, Wetland and aquatic treatment systems, Treatment and disposal of sludge (solids and biosolids): thickening, stabilization, digestion, conditioning, dewatering

1614590 Air Pollution and its Control **3 Cr.** Introduction & Definitions, Air Pollution Sources, major pollutants and their effects , Air Pollution Standards and Air Pollution Index, Particulate Matter, Settling Chambers, Cyclones, Electrostatic Precipitators, Fabric Filters, Wet Scrubbers, Control of Gases, Meteorology, Atmospheric Dispersion Modeling

1614592 Solid Waste Management **3 Cr.** Introduction, Solid Waste Generation Rates & Composition, Collection of Municipal Solid Waste , Separation & Treatment Processes , Composting Process , Landfill Disposal, Landfill gas generation, Landfill leachate generation

1614580 Water Resources Quality Control **3 Cr.** Physical, Chemical, and Biological Parameters Relating to Streams, Estuaries, Lakes and Reservoirs, Water uses and Water Quality Goals, Objectives and Criteria, Limnology, Stratification, Eutrophication, Principles of Water Quality Modeling and Waste-load Allocation, Transport and Transformation of Chemicals in Water Resources.

1614581 Groundwater **3 Cr.** Introduces Fundamental Government Principles, The Movement of Water and Contaminants in Groundwater Systems, Physical Properties of Groundwater and Aquifers, Principles and Fundamental Equations of Porous Media Flow and Mass Transport, Well Hydraulics and Pumping Test Analysis, Groundwater Quality and Contamination.

1614584 Groundwater Modeling **3 Cr.** Introduction to groundwater theories, Groundwater in the hydrologic cycle, Quality of groundwater. Sources of pollutions, Pollution in relation in water use, Measures of water quality, Water quality criteria, Distribution of pollution underground. Properties of aquifers: porosity, hydraulic conductivity, specific yield, specific storage, transmissivity. Mass transport of solutes in saturated media, Diffusion, Advection, Mechanical dispersion, Hydrodynamic dispersion. Transformation, Retardation and attenuation of solutes. Numerical methods in groundwater flows (finite differences), different initial and boundary conditions, stability of scheme. MT3D-MS Description, External source and stress, Solver packages, Case study. Remediation technologies of polluted groundwater**.**

1614591 Industrial Wastewater Treatment 3 Cr. Sources and characteristics of industrial wastewaters, industrial waste survey, industrial waste minimization, pretreatment of industrial waste, water reuse, theory and design of neutralization, equalization, API and DAF, in-plants, specific industries will be discussed.

1614589 Wastewater Treatment 3 Cr. Theory and design of systems for treating municipal wastewater: Methods for characterizing wastewater properties, physical, chemical, and biological processes, including primary treatment, microbial kinetics of biological processes, activated sludge, fixed film reactors, anaerobic digestion, nutrient removal, and natural treatment.

1614585 Water Distribution Systems 3 Cr. Emphasizes the Mechanics of Water Flow in Pipes and Pipe network Systems , Municipal Water Uses and Quantities, Conservation Laws and Headless Formulae, Equivalent Pipes, Reservoir, Pumps, Formation of Equations, Hardy Cross Method, Newton-Raphson Method, Linear Theory Method, Surge and Water Hammer Problems.

1614587 Hazardous Waste Management 3 Cr. Introduction, Review of Organic Chemistry, Properties and Classification, Waste Generation Rates and Composition, Toxicology, Treatment and Disposal, Site Investigation, Site Remediation, Separation & Treatment Processes, Landfill Disposal (covered in Solid Waste Management)

1614593 Water Chemistry 3 Cr. Introduction, Chemical Kinetics, Chemical Equilibrium , Acid-Base Chemistry , Coordination Chemistry, Precipitation and Dissolution , Oxidation and Reduction , Chlorine chemistry, Corrosion, Solid-Solution Interaction, etc

1614588 Wastewater Collection Networks 3 Cr. The Basic Methods of Wastewater Flow and Measurement, Types of Collection Systems, and Sewers, Design of Gravity - Flow Sewers, Sewer Appurtenances, Infiltration / inflow, Pumps and Pump Systems, Design of Pumping Stations, Analysis of Pump Systems, Corrosion and Odorous Control

COURSE DESCRIPTIONS for the Degree of Master of Eng. in Civil Engineering, Major: *Hydraulic Structures Engineering*

1614575 Advanced Hydraulics 3 Cr. Cavitations control in rapidly varied flow. Supercritical flow in open channels. Specially varied flow. Gradually varied and rapidly varied unsteady flow. Storage and river flow roofing.

1614577 Hydrodynamics 3 Cr. Flow of an ideal fluid, flow of a real fluid, graphical flow nets, numerical analysis and experimental analogies, standard patterns of flow, conformal transformation

1614578 Numerical Methods in Water Engineering 3 Cr. Basic partial differential equations used in surface and subsurface hydrology. Basic concepts of finite difference and finite element methods. Application of numerical methods using the related equations.

1616557 Earth Dams 3 Cr. In this course the design and analyses of earth and rockfill dams are discussed and it can be divided into five basic subjects as: Materials cut off methods, drainage systems, design and foundations.

1614598 Hydraulic Structures 3 Cr. Elements of dam engineering, embankment dam engineering, concrete dam engineering, dam outlet works, energy dissipation, gates and valves, dam safety, diversion works, hydroelectric power development

1612527 Dynamics of Structures 3 Cr. Fundamentals of dynamic of particles & rigid bodies, differential equations, single degree freedom systems, Duhamel's integral, response spectrum, multi-degree freedom systems, systems with distributed mass & elasticity, analysis of frames under base motion for shear & axial forces & bending moments.

1612528 Theory of Plates and Shells 3 Cr. Introduction, circular plates, rectangular plates, plates of various geometrical forms, plate bending by numerical method, plates under combined lateral and direct loads, membrane stresses in shells.

1612529 Finite Element Method 3 Cr. **Introduction to the Use of Finite Elements:** Physical Problems and Mathematical Models, **Formulation:** Mathematical Fundamentals, Weighted Residual Approximations, Weak Formulation and Galerkin Method, Approximation in Solution of Differential Equations , Approximate Solution to Systems of Differential Equations, Differential Equations in Engineering Problems (Solid Mechanics, Heat Conduction), Virtual Work for Solid Problems, Variational Principles in FE Formulation, Continuity Requirements, Piecewise Trial Functions, **The Concepts of Element and Shape-Function**: One Dimensional Lagrange Shape-Functions (Linear and Higher Order Elements), Hermite Polynomials for Shape-Functions with Higher Continuity, Two Dimensional Quadrilateral Elements with Lagrange Polynomials, The Concept of Mapping, Isoparametric, Sub-Parametric and Super-Parametric 2D/3D Elements, Triangular an Tetrahedral Elements, Numerical Integration, Plate Formulation and Elements, Axisymmetric Solid/Shell Problems and the Associated Elements .

1614600 Concrete Dams 3 Cr. An introduction to dam engineering, Definition of concrete dam, Types of concrete dams, Site assessment and selection and selection of type of dam criteria, Gravity dams analysis, Arch dams analysis, Buttress dams analysis, Loads on dams, Stability of dams, Earthquake loading and risk analysis, Dynamic loading, Thermal loading, Reservoir and its equation of motion; Boundary conditions, Fluid-structure interaction, Modeling of the dam-reservoir system, Experimental studies of small scale dam models, Concrete dam construction, Dam safety, Instrumentation and surveillance

1614604 Marine Structures 3 Cr. An Introduction to Hydrodynamics, Airy Wave Theory, Higher order and stretch wave theories, Irregular Sea States, Environmental Loads on Offshore Structures, Wind Loads, Wave Loads, Transverse (Lift) wave loads, Diffraction wave forces, Effect of compliancy (relative motion), Seismic Loads, Types of Offshore structures, Structural Analysis, Foundation Design

1612600 Marine Structures 3 Cr. Earthquake Ground Motion, Seismic Behavior of Structures
Ductility and Modeling of Load Bearing Systems, Elastic and Inelastic Earthquake Analyses of Structures
Introduction to Performance Based Design, Structural Control, Soil-Structure Interaction